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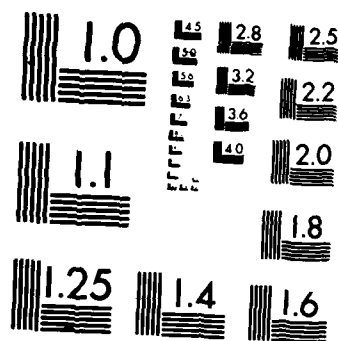   ENGINEERS OF THE NAVAL SEA SYST   J DETOLLA ET AL

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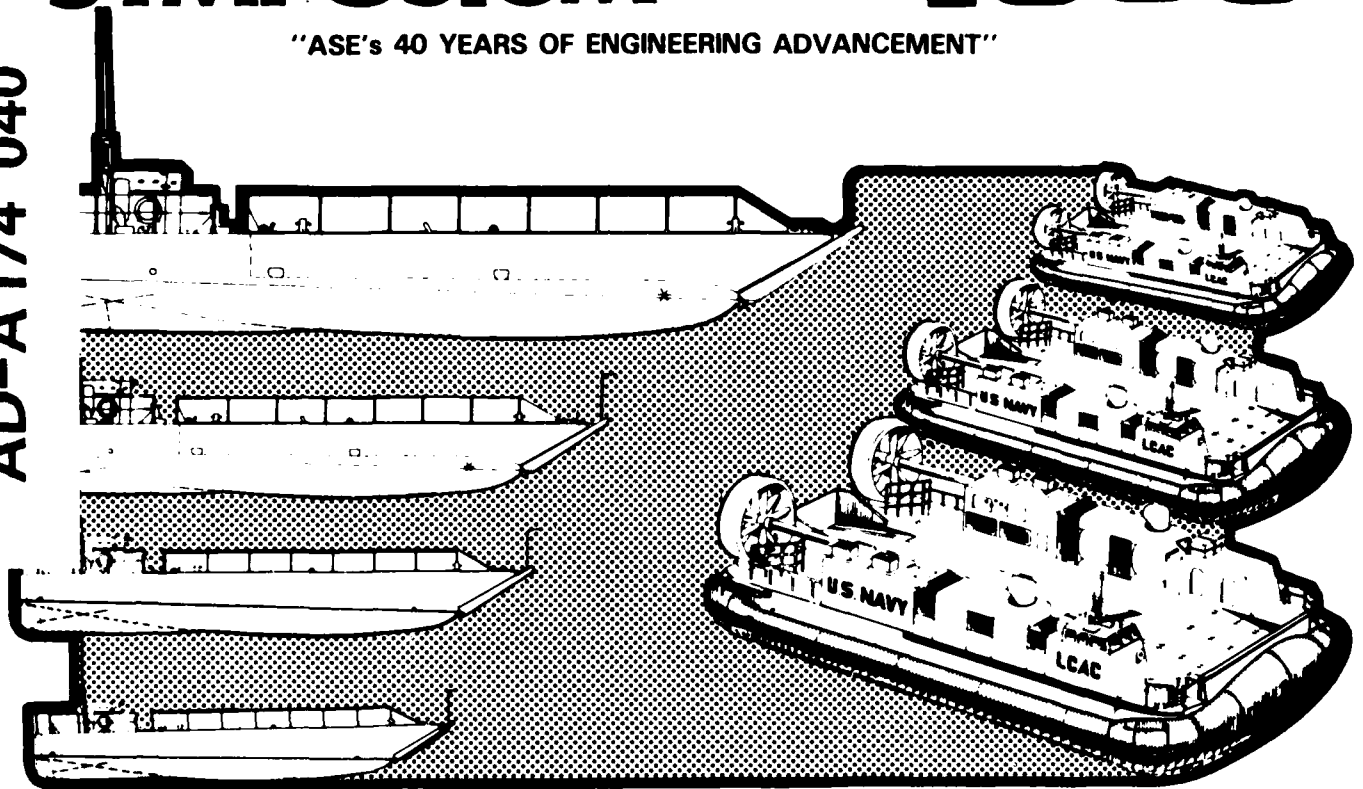MICROCOPY RESOLUTION TEST CHART
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"ASE's 40 YEARS OF ENGINEERING ADVANCEMENT"

ENGINEERING MANAGEMENT APPLICATIONS OF COMPUTERS AND DATA PROCESSING

by: J. Detolla/J. Detolla

ENGINEERING MANAGEMENT APPLICATIONS OF COMPUTERS

AND DATA PROCESSING

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ABSTRACT

As computer technology and all that it encompasses have expanded through the years, several areas of specialization have appeared. From a user's viewpoint, some of these specialties are: CAD — computer aided design, CAM — computer aided manufacturing, CAI — computer aided instruction, and document processing systems. Very fundamentally, the computer which serves as the basis for these specialties remains the same. The commands given to the computer, the functions it carries out, and the output it provides are tailored to the needs of various user groups.

This focusing on categories of applications, is efficient and results in products most easily employed by the intended user. However, it also creates limited perceptions of what computers do. Computers were first mathematical wizards, then obstinate billing machines. Now they are animated game players, automated typewriters, 3-D design machines, and many other marvelous things. Though, even today accounting, inventory control, billing, and payroll constitute the greatest uses of computer resources. Specialization has resulted in a "polarizing" of the users.

This paper briefly explores areas of computer applications and relates examples which the authors see as obstacles to an integrated ADP system. A survey of computer systems planning and design is presented from the organizational perspective. The paper offers a summary of general issues of software applications, and concludes with views on training as part of the overall computer system implementation process in a large, specialized organization.
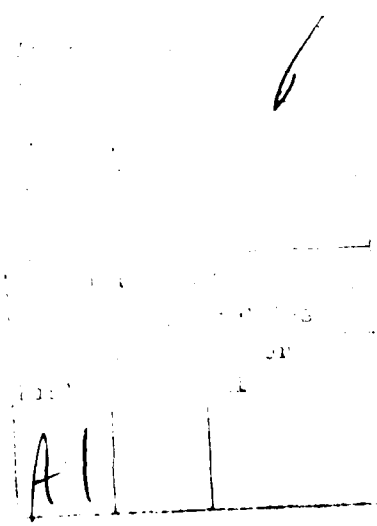
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INTRODUCTION

"Hold it! Before you go, let me show you my new computer," the young engineer shouted obviously ecstatic about his new office computer. "It can do so many things," he informed me, "You should try to get one too." My curiosity now piqued I paused and stared at what by now had become the rather commonplace looking keyboard and monitor. He offered to demonstrate some of its capabilities. He flipped the on-switch; we waited as it warmed up. Then, within moments, the screen came alive with welcome messages. As he deftly punched the typewrite-style keyboard in response to one set of commands after the other appearing on the screen - he informed me that these were called menus; he described how he would demonstrate the directory feature by finding someone's phone number. It seems this computer allowed you to preload it with a telephone directory. I watched as he keyed his way through one menu after the other until finally, some six or seven minutes after flipping the on-switch, there it was beaming from the terminal screen - the individual's name and phone number. The young man grinned smugly, having demonstrated his adeptness. His expression drooped, as he lamented that if he only had a self-dialing modem he could show me how the computer would dial the phone, too. I sympathized with him, but anxious to go, I deferred a demonstration of the computer calender. As I left, I wondered why he had not simply used the phonebook.

Yes, this is a true story, and you can probably think of other similar experiences. To be plain, this paper is not going to be a cynical repartee of computer software applications. Indeed, the benefits of computers to modern life could only be understated here. But, it seems, with the easy access many of us have to automated data processing equipment in our offices and homes, that we have arrived at a point where new and beneficial applications are not obvious.

The most common applications of computer resources are accounting, inventory control, billing and payroll. Word processing, an application of the storage and retrieval capability of computers, is the fastest growing ADP area for both the home and office.

Future developments in the next fifteen years are expected in computer hardware: computer chips smaller than a dime with capacity greater than today's mainframe processors, faster and higher capacity pocket-sized personal computers made possible through micro-electronics, and direct access data storage systems offering a ten-fold or more increase in the density of data storage. Experimental work in the computer's central processor using an ultra-high speed conducting state called "ballistic transport" shows the potential by the 1990's for systems that are 1,000 times faster than today's. Expanded use of distributed processing and broader data bases are predicted to aid future business management decision makers. Within the next few years, rapid advancements are predicted in computer-aided engineering (CAE) combining sophisticated analytical software with computer-aided design (CAD) graphics workstations. Not to be overlooked, although we may not call them "computers", the

explosion in electronic technology has had significant effects on products that did not exist ten years ago, or at least operated differently, like digital display devices, microwave ovens, VCR's, security systems and, of course, our cars. But, the point of this paper is not to forecast the glowing future of micro-electronics and computers, the biography lists many texts which do an excellent job of it.

The purpose of this paper is to focus on some of the problems of implementing computers in a large organization like NAVSEA. By presenting these issues, and offering contrasting viewpoints, we hope that this paper will stimulate the reader's own thoughts on the role of computers in a large organization.

PEOPLE AND COMPUTERS

A premise of this paper is that implementing the use of computers (taken here mainly to mean computer software) is to a very large extent, a personal initiative. Of course, the acquiring of the hardware, software and data bases require action by the organization. A process which is sometimes so lengthy that the individual at the root can be overlooked. It is, therefore, worthwhile to look at how individuals relate to computers in the office.

From a review of computer and ADP management texts on this topic, it would seem that many authors choose to by-pass this issue. Several texts take the convenient approach of discussing the implementation of computers in an organization along with the "building" of a new organization. That is, rather than explaining methods of integrating computers into the office to be used by the existing staff, selection criteria for hiring computer and word processor operators and suggested ADP organization charts are offered. Even training is couched in terms of orientating the experienced computer operator to the real business of the organization. The extent of this type of computer centered viewpoint from those who should advise on ADP implementation in the workplace is regretable. This perspective has hindered the application of computers in professions which seek more than to use them as "business machines."

For specialized fields such as naval ship design and life cycle management, the expertise of the individual in areas like naval architecture, marine engineering, and ship logistics support, just to name a few, take precedence and computer skills become an adjunct.

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Here are some reasons why people may be negative, or at least ambivalent, toward computers in their workplace:

Threat of Job Security:

Computers have had a real history of replacing individuals or whole departments by changing the way work is done in commerical businesses. In areas of special expertise, such as ship design and support, change has occurred more slowly and loss of jobs to computers is less of a concern. However, in an organization where the initiative for automation lies with the working specialist, concern for job security or at least changing how things are done can act as a retarding force.

Reduction in Job Satisfaction:

The introduction of computers or word processors in the office usually changes how things are done. It may mean reorganizing, breaking up the informal organization, or being given more work. Most people find the computer an invaluable aid and find their increase in productivity satisfying. But, in the short-term changes in the office setting, and social structure combined with the demands of learning how to use the new computer can be frustrating.

Loss of Status and Reputation:

A lack of knowledge and experience with computers can weaken an individual's self-confidence. Likewise, a person may be concerned about his ability (or time) to learn new skills. There is no denying that generation gaps exist in computer literacy. The jargon of computers seems to place younger computer enthusiasts in a particularly smug position when explaining a software application to their supervisors. Likewise, should the manager choose to attempt to operate the computer, he is subject (with high probability) to the intolerant flashing of cryptic ERROR messages on the terminal screen, which some find most upsetting. Fear of losing status and prestige or an "it's too late to start" attitude is an important reason for resistance by both senior managers and employees.

I Can't (Won't) Type:

For alpha-numeric character input terminals use a typewriter style keyboard, thus implying a proficiency in typing skills to efficiently operate the computer. Surprisingly, this is a source of great resistance, particularly for upper-management, probably stemming from a perception that typing is for secretaries and clerks. Interactive pre-processing software is now used with many programs. The user operates the program by making choices from "menus" of commands appearing on the terminal screen, thus

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making "single-digit" computer operation a reality. Other types of input devices exit. Optical scanners read the darkened dots on test forms, or the account number of your checks, or the bar codes on supermarket labels. Digitizers convert the continuous image of a drawing into digital "point by point" data. A light pen placed directly on the terminal screen may be used to input menu command selections or draw on the screen. There are many other input devices; but for now when there is text data to input to a computer system, the man-machine interface will probably be the keyboard.

Fear of Breaking the Computer:

ADP equipment is not inexpensive. Typical desk top office word processors and personal computers range in price between $3,000 to $12,000, with engineering graphics work stations and mini-computers costing much more. Office computers are a relatively scarce resource. When one is down for repair, it is usually noticed and the last individual to have used the computer bears the indignation of his peers (if not the guilt). This is a cause of further reluctance by some persons to use the office computer. It is important to know that you can not "break" a computer through inputs from the keyboard. The processors and printers are sensitive to impacts, in particular, the disk drives. Normal care and handling - the same as for a home TV or VCR - should safeguard against "crashing the Winchester disk".

Probably the best way to deal with many of these issues is first simply to admit to them. The nice thing about computers is that no one really knows where the next innovations will take us, and there are always new hardware systems and software appearing. That fact helps to keep down the number of real "computer experts" in the office. We are all learners. A review of computer management texts leads to the conclusion that the reluctance of most people toward computers stems from personal perceptions rather than skill limitations. Some companies even offer counseling and classes to allay "computer phobia". Later in the paper, some ways to learn more about computers are discussed.

ORGANIZATIONS AND COMPUTERS

While the focus of this paper is on the individual in a highly specialized profession, this section briefly discusses organizational considerations and planning for the use of computers. It is important to recognize from the beginning that computers may be used to support two divergent organizational needs: production and management. For us, production may take on the names: computer-aided engineering, computer-aided design, or computer-aided logistics. Management functions encompass the traditional areas of payroll and accounting, as well as, data base management systems for controlling and monitoring.

A logical approach to computer systems development includes the following six steps: problem definition, system analysis, system design, programming analysis, program preparation, and system implementation and maintenance.

The objective of the first step, problem definition, is to clearly and accurately state the need or problem which exists. The scope of the problem or need for which solutions will be studied is established. Specific goals and requirements to be achieved are defined. Frequently, it is found that the initial assessment of the problem or need is too broad. In that case, the scope of the problem to be tackled should be scaled down to control the study and achieve tangible results in a reasonable period. The overall problem may be met through a series of incrementally phased-in solutions. The importance of this initial planning phase cannot be overestimated, since it sets the direction for the study that follows and the criteria against which alternative solutions will be measured. People are biased about computers, pro and con. Additionally, any solution which includes the use of computers will more than likely mean a change from how things were done. To be successful, it is important from the outset that the problem definition phase have management support, involve representation from a cross section of the organization, and be unbiasedly objective.

The second step is system analysis. During this phase, the current procedures are described as a basis for comparison. The current procedures are evaluated to locate the problem areas and identify where the new requirements and goals are not met. The system analysis also sketches possible alternative solutions and estimates the scope and cost of the potential solutions.

During system design, the details of alternative feasible solutions are developed. Regretably, many computer implementation studies stop before getting to this point, usually for lack of management support. They remain essentially "wish lists" without comparative data to show just how much productivity would have improved or how much more expensive the system would have cost. Indeed, the investment in time just to conduct the feasibility study is not small. But, in a period where obvious computer system solutions do not readily present themselves, automation feasibility studies are even more essential. At the organizational level, key considerations during the systems design phase include the effects of alternative systems on organizational structure, physical facilities, personnel, hardware, software, security, acquisition methods, costs, benefits, and anticipated problems. The results of the system design phase serve as the basis for a management decision on system selection and implementation.

The software development phases should also follow a systematic approach for defining requirements and documenting the proposed programs and manuals. The program analysis phase clearly and precisely describes a complete set of requirements for the software. An important starting point

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is to define the environment or process which the software will support, and the characteristics of the type of hardware system on which the program will operate. Functional and performance requirements are established, such as, programming language, standards, inputs, processing, and outputs. Program interface and data base requirements are described, as are any security requirements. Acceptance criteria for the software to be demonstrated during the formal testing are also defined. Programming tools such as flow charts and decision tables are used to analyze and describe the proposed programs.

A major issue for the program preparation phase is whether to "make or buy" the software. Thousands of packaged programs are commercially available. Indeed, some software search firms have made a business of just matching packaged programs to clients' needs. Packaged programs offer benefits of lower cost, faster implementation and reduced risk of undetected "bugs" in the programs. Documentation for packaged programs is usually of higher quality and computer-based training software may also be available. Unfortunately, for many specialized engineering applications, packaged programs simply do not exist. Also, packaged programs are not easily tailored to meet specific needs and, therefore, must be traded-off against previously defined organizational requirements.[1]

TOWARD USEFUL COMPUTER APPLICATIONS

The program development plan described in the previous section was presented from an organizational management viewpoint, but it applies equally to the individual and his desk top P.C. Three books worth mentioning which give extensive treatment to system analysis and design are: Computers Today by Donald Sanders, Introduction to Computers and Data Processing by Gary Shelly and Thomas Cashman, and Office Automation – A Management Approach by Kathleen Wagoner and Mary Ruprecht. These books are available from the NAVSEA Technical Library. The Computer Supported Design Project Software Development Standard prepared by the Naval Sea Systems Command Computer-Aided Engineering Office, SEA 507, provides standards, technical requirements and management requirements for the software development process. Even on an individual basis, it is well worthwhile to go through this systematic approach to identify useful computer applications and match the tasks to hardware and software systems that will give acceptable performance.

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1. For most packaged programs, only executable files written in machine code are normally purchased. This is in contrast to source programs which are written in a high-level programming languages, such as FORTRAN or BASIC, and are more easily modified.

The following are some additional items to consider when planning computer applications:

What is the Nature of the Work?

Computers still retain their aura of mathematical wizardry, and for technical specialists there is a strong tendency to propose the use of computers to perform complex analyses. The need for such analyses should be clear from current practices. The software planner should be watchful of proposals for programs which, while technically appealing, go beyond supporting production needs. As a first step toward implementing computers, applications should be directed toward reducing the preparation time, speeding-up the response, improving the accuracy, and ensuring consistancy of routine tasks. If there are obvious needs, such as word processing, or technical data cataloging, or simpler repetitive calculations, then these should be considered first.

A Data Base in Every Office!

Where exotic analytical programs have their special appeal to the systems design engineers, data bases are the vogue of the equipment managers. All too often in the planning phases the attention is focused on the computer hardware and data base management system. At NAVSEA, data base management system software is accessible in most offices. Some examples are the Relational Information Management System (RIM) on the SEA 05 Engineering Data Support Branch's VAX micro-computer system, or for desk top processors Datatrieve software for the DEC PC350 and D-Base for the IBM PC, just to mention three. The real work associated with a data base is collecting and formating the information, and then transcribing the data into the computer. Unless the need requires frequent sorting, or locating information by specific categories - like a listing of all destroyers, with steam propulsion plants, which have less than three Model XYZ compressors installed on them - then a simpler data filing scheme, such as a card index or a loose-leaf notebook of data sheets, might be more appropriate, easier to manage, and less costly.

Common and Current Data for All.

Allied with the idea of a computerized data base is that large numbers of related organizations can all work with common and (instantaneously) current information. A simple but recurring problem is that all the users of the information system must possess compatible input/output hardware, lest the system quickly degenerates to a "quasi-computer based" paper copy information exchange, with the available output devices doing the typing. Hardware and communications issues within just one office complex can present barriers to integrated data processing systems. Digital pulses cannot effectively travel any distance over the

transmission network that was designed years ago for voice communication. The need to transmit large volumes of computer data over longer distances has, in itself, created a new industry. The benefits from high-speed computer data communications networks are significant. Such applications as electronic mail, hotel and airline reservations, electronic funds transfer, and regional sales and inventory control are common place today. Time is the major factor, because the benefits of real-time processing are only realized when the output from the system requires and receives immediate action.

The Omnibus Design Program.

This is an attempt to develop a program which takes simple basic characteristics as inputs and provides the detailed final solution as output. (It may be the computer age replacement to the perpetual motion machine.) A surprisingly frequently proposal which could lead to an endless meandering in search of elusive correlations which transform the fundamental inputs into the final output. Systematic software planning, in particular, attention to the existing procedures or design processes, will highlight areas where some practices and criteria are not sufficiently well defined to allow computerization.[2]

LEARNING ABOUT COMPUTERS

Operating a computer requires some competence in unique skills. There is little, if anything, about using a computer that is intuitive. Computer skills are acquired through learning. This learning may be from formal training or a variety of other means. Training is an essential part of the computer system or software implementation phase. Frequently, the details of an effective training program are not developed in a system implementation plan, because it is one of the last elements in the process. The training element often bears the effects of underestimated costs for hardware acquisition and software development, occurring earlier in the process. Also, because training is a specialty in itself, the computer-oriented system planner may not allocate sufficient funds for that purpose. In a large organization, the responsibilities for ADP planning and computer system training may be delegated to different specialized organizational units, thus adding coordination problems.

Learning will take place whether formal training is offered or not. However, without planned training learning may be hit-and-miss, may be

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2. The Integrated Computer-Aided Manufacturing Definition function modeling (IDEFo) method described in the Computer Supported Design Project Software Development Standard provides an excellent planning aid for graphically representing and analyzing existing and proposed processes.

inadequate, and may lead to inefficient use of computers and frustration.

Training may take on many forms: on-the-job training, classroom training delivered by the organization or training specialists, and vendor training. Training at a computer workstation in the office has several advantages. The individual obtains "hands-on" experience in the work environment on the office hardware. The trainee also gains experience with the specialized software used in his office. On-the-job training is the least cost option. Disadvantages of on-the-job training are: it is usually limited to one trainee at a time, it can preoccupy the time of a more skilled employee who is delivering the training on a one-on-one basis, and where there are limited computer resources it can tie-up the productive use of a terminal or personal computer. On-the-job training is probably the least planned method of teaching ADP skills. However, the use of hardware and software documentation, introductory guides and, in particular, interactive computer-based instruction courses can help to avoid uneven training.

Classroom training offers the benefits of making a uniform training program available to many individuals in a setting away from the distractions of the office. However, to serve a large group, the course content may be more general, with no mention of unique software applications. Also, "hands-on" hardware training is frequently not available in the classroom situation. This method of training, whether it is offered "in-house" using the organization's training specialists or held at a local college, is a more costly alternative than on-the-job training. Average tuition costs for two to five day courses range from $60 to $250 per day, depending on the training location.

Vendor training is generally appropiate where specialized training is required in advanced hardware and software areas, such as three dimensional computer graphics systems. This type of vendor training is high in cost. Vendors frequently offer introductory hardware operating training bundled into the initial acquisition cost of new hardware or large software purchases.

For effective organizational implementation of the use of computers, a full scale training program involving frequent computer users and management is essential. A complete training program should include overview courses in hardware, software, system operation, data bases, and programming to ensure a measure of computer-awareness throughout the organization. In-depth courses should be available in each of these major topic areas to suit specific organizational needs.

If formal training programs are not available, other avenues to learn more about computers exist. Books and magazines are a good starting place. They are abundant and readily available. (The bibliography suggests some introductory texts, many of which are available from the NAVSEA Technical Library.) Other sources of involvement in computer learning, though many concentrate on specialized applications, are "user groups" or computer

clubs. Some that are currently active in NAVSEA are: the NAVSEA Computer Club, the Computer Supported Design Project's Computer-Vision User's Group, and the Digital Equipment Computer Users Society. Periodically, tuition free training is made available, such as the course "An Introduction to the VAX 11/780 Computer"[3] offered by the NAVSEA Engineering Data Support Branch, SEA 05F2.

Not everyone needs to be a skilled computer user. However, in today's large organization it is highly unlikely that any of us can escape the impacts of automated data processing. Whether your involvement is operating a computer, preparing input data, using computer output, supervising or planning computer systems for the future, training - to suit your needs and depth of detail - is a major element in accepting computers and understanding their potential to meet organizational goals.

CONCLUSION

In summary, this paper has presented views on how individuals relate to computers in the workplace, reviewed the organizational planning process for effective computer system implementation, suggested some considerations for useful computer applications, and discussed training as a major element in the computer implementation process.

While this paper has discussed many elements of computer applications from an organizational perspective, the focus always shifted back to the individual. This is considered appropriate, because in the highly specialized organization the key to effective computer applications lies with YOU.

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3. Participation in this course is subject to space limitations and other restrictions.

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The following books were very useful in the preparation of this paper. Some are available at local libraries, and all are recommended for their introductory approach to computers.

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